

## ORIGINAL ARTICLE

# Laparoscopic spleen-preserving distal pancreatectomy in elderly subjects: splenic vessel sacrifice may be associated with a higher rate of splenic infarction

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## Abstract

**Background:** Laparoscopic spleen-preserving distal pancreatectomy has gained popularity in recent years. Splenic preservation can be achieved with or without splenic vessel preservation (SVP). The potential morbidity of this approach in patients aged >70 years has not been well defined.

**Methods:** Ten patients aged >70 years underwent attempted laparoscopic spleen-preserving distal pancreatectomy within a 2-year period. Multiple patient parameters were examined and chi-squared analysis was used to evaluate the association between the operative technique (SVP or splenic vessel division [SVD]) and splenic infarction. The Mann–Whitney test was used to compare the SVP and SVD groups with regard to age, estimated blood loss (EBL), operating time, splenic volume and length of stay (LoS).

**Results:** Median age was 81 years (range: 71–92 years). Operating room time, LoS, EBL and complication rates were similar to those reported in published series of younger patients. In four patients, the splenic vessels were divided in a manner relying on short gastric collateral flow; SVP was achieved in all other patients. All four patients who underwent SVD developed splenic infarcts and three required splenectomy to manage this ( $P = 0.002$ ). Median LoS was increased in the SVD group (9.3 days vs. 4.3 days;  $P = 0.053$ ). Estimated blood loss was higher in the SVP group (200 ml vs. 100 ml;  $P = 0.091$ ). One pancreatic leak occurred. There were no mortalities.

**Conclusions:** Spleen-preserving laparoscopic distal pancreatectomy can be performed safely in elderly patients, with results comparable with those achieved in younger subjects. However, elderly patients undergoing division of the splenic artery and vein may be at higher risk for splenic infarct and the aetiology of this is unclear.

## Keywords

laparoscopic distal pancreatectomy, elderly, splenic preservation

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## Introduction

As the population of the USA ages and the use of computed tomography (CT) increases, more pancreatic cysts and neoplasms will be discovered in elderly patients. This has generated increased

interest in the outcomes of elderly patients undergoing major surgical procedures, such as distal pancreatectomy. Elderly patients are known to have increased morbidity and mortality after major open pancreatic resections.<sup>1</sup> In addition, postoperative elderly patients may suffer from increased rates of malnutrition and other comorbidities, thereby increasing the likelihood that they will experience wound infections and other complications.<sup>1–3</sup>

Of the several actions that may minimize morbidity and mortality in elderly patients with distal pancreatic lesions, the use of

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laparoscopy has been shown to reduce short-term complications in these high-risk patients. Particularly, laparoscopic distal pancreatectomy has gained in popularity and splenic preservation has become more common. The present report describes the outcomes of laparoscopic spleen-preserving distal pancreatectomy in a group of elderly patients with a median age of 81 years, and evaluates the safety, feasibility and potential morbidities associated with performing this procedure in this subpopulation. Furthermore, the impact of splenic vessel sacrifice on perioperative morbidity is evaluated.

## Materials and methods

At the Roger Williams Medical Center (RWMC), 10 patients aged >70 years who underwent laparoscopic distal pancreatectomy with splenic preservation between June 2008 and August 2010 were identified. Data were recorded on age, length of stay (LoS), estimated blood loss (EBL), operating room (OR) time, preoperative endoscopic ultrasonography (EUS) and imaging findings, final pathologic diagnosis, splenic volume,<sup>4</sup> presence of atherosclerosis and its associated risk factors, and haemodynamic parameters. Operative technique was described and chi-squared analysis was used to evaluate the association between the operative technique (full splenic vessel preservation [SVP] or splenic vessel division [SVD]) and the diagnosis of splenic infarction. A Mann–Whitney test was used to compare the SVP and SVD groups with regard to age, EBL, OR time and LoS. Splenic volume was measured using preoperative CT scans according to the methodology of Rezai *et al.*<sup>4</sup> Finally, the presence or absence of stigmata suggesting atherosclerosis or potential haemodynamic causes of infarction were documented.

All pancreatic transections were performed with a laparoscopic endomechanical stapling device. Passive peripancreatic drains were routinely placed. The specific techniques of splenic preser-

vation were also recorded. These were divided into SVP techniques, in which the splenic vein, artery or both were preserved, and SVD techniques in which both the splenic vein and artery were divided (Warshaw technique), relying on short gastric collateral circulation to supply the spleen.<sup>5</sup> When the splenic vessels were divided, the short gastric vessels were preserved, as were the splenic flexure and splenocolic ligaments. The minimum amount of dissection of the gastrocolic ligament that still allowed for visualization of the pancreas was used.

## Results

### Patient population

The median age of the cohort was 81 years (range: 71–92 years). Seven patients had an American Society of Anesthesiologists (ASA) score of 3 and three had an ASA score of 2. Pancreatic masses were found incidentally on CT scan in four patients, were identified during evaluation for chronic abdominal pain in four patients, and were known pancreatic cysts which increased in size during surveillance in two patients. Eight patients underwent distal pancreatectomy and two underwent subtotal pancreatectomy.

### Operative results

The median OR time was 180 min (range: 120–270 min) and the median EBL was 100 ml (Table 1). The median LoS was 5 days (range: 2–15 days). Four patients received a perioperative blood transfusion; the median blood transfusion required was 0 units (range: 0–2 units). One spleen was not preserved because adenocarcinoma was found to be invading the splenic hilum at surgery. The other nine patients underwent spleen-preserving distal pancreatectomy. Of these nine patients, the splenic vessels were preserved in five (SVP group) and divided using the Warshaw technique and relying on short gastric collateral flow in four (SVD group).

**Table 1** Characteristics of 10 patients undergoing spleen-preserving laparoscopic distal ( $n = 8$ ) or subtotal ( $n = 2$ ) pancreatectomy

Patient	Age, years	Diagnosis	OR time, min	EBL, ml	LoS, days	SVP	Complications
1	89	Adenocarcinoma	210	200	3	Yes	
2	74	Adenocarcinoma	255	400	5	No <sup>a</sup>	
3	83	IPMN	120	250	4	Yes	
4	81	Invasive IPMN	140	50	2	Yes	
5	73	IPMN	330	200	10	Yes	Subclinical pancreatic leak
6	84	Chronic pancreatitis	150	50	10	No	Splenic infarct (managed non-operatively)
7	74	IPMN	170	100	7	No	Splenic infarct with abscess (splenectomy)
8	73	NET	130	50	2	Yes	
9	92	SCA	122	100	15	No	Splenic infarct (splenectomy)
10	77	IPMN	210	100	5	No	Immediate splenic infarct requiring splenectomy
Mean	79		194	150	6		
Median	80		180	100	5		

<sup>a</sup>Splenectomy required because of tumour invasion of the splenic hilum.

OR, operating room; EBL, estimated blood loss; LoS, length of stay; SVP, splenic vessel preservation; IPMN, intraductal papillary mucinous neoplasm of the pancreas; NET, neuroendocrine tumour; SCA, serous cystadenoma.

All four patients in whom the splenic vessels were divided developed symptomatic splenic infarcts. In one patient, aged 77 years, the infarct was detected as a large, almost complete infarct intraoperatively and laparoscopic splenectomy was performed at the time. Another patient, aged 84 years, complained of postoperative pain and a splenic infarct was diagnosed on postoperative CT and managed conservatively. Two other patients (aged 74 years and 92 years) required interval laparoscopic splenectomy during the same admission because of persistent focal postoperative peritonitis of the left upper quadrant and flank. The first of these patients had a necrotic spleen with subphrenic abscess, which revealed methicillin-resistant *Staphylococcus aureus* and *Bacteroides fragilis* on culture. Overall, the use of the vessel-dividing technique and the occurrence of symptomatic splenic infarct were significantly associated (four of four patients;  $P = 0.002$ ) in this population. A search for features suggestive of atherosclerosis revealed that all 10 patients had hypertension requiring medication. One patient (in the SVP group) had undergone coronary bypass surgery before pancreatotomy for coronary artery disease (CAD) detected during the preoperative evaluation. All of the other patients underwent some form of preoperative stress testing, and none had documented CAD. Two patients in the SVP group had diabetes. In addition, operative and postoperative blood pressures were reviewed; no haemodynamically significant decreases in blood pressure (systolic:  $<110$ ) occurred in any of the patients who had splenic infarction. The four pathologic specimens from the Warshaw technique group were examined for evidence of atherosclerosis in the splenic vessels and were found to have mild to moderate age-appropriate atherosclerosis, but no occlusive or stenotic lesions. Finally, the CT scans of the entire group were reviewed for coeliac axis calcifications and/or the presence of coeliac stenosis, but no differences emerged.

Other differences between the SVD and SVP groups were noted but did not reach statistical significance (Table 2). Median LoS was increased in the SVD group (8 days, range: 5–15 days) compared with the SVP group (4 days, range: 2–10 days) as a result of the extra time required to manage the splenic infarctions. Mean EBL

(191 ml vs. 87 ml) and OR time (178 min vs. 150 min) were increased in the SVP group, presumably as a result of the need for more dissection and division of multiple, small, feeding pancreatic vessels. There was also a small increase in splenic volume (by CT) in the splenic infarction group (Table 2), but this did not reach statistical significance. The only other pancreatotomy-related complication was a pancreatic leak that was managed conservatively with resolution. No wound infections requiring antibiotics or wound reopening occurred. There were no mortalities.

## Discussion

Elderly patients are known to have higher rates of morbidity and mortality after open pancreatic surgery. One large study examining 3113 elderly patients who underwent open pancreaticoduodenectomy or distal pancreatectomy in California found a mortality rate of 10%.<sup>1</sup> Patients aged  $\geq 75$  years were more likely to suffer major cardiac events (13%), require admission to the intensive care unit (47%), require tube feeding at discharge (48%) or require skilled nursing care at discharge (24%) than their younger counterparts.<sup>1</sup>

Since the development of the laparoscopic approach to distal pancreatectomy, the usual benefits of a minimally invasive approach have been apparent and the approach has been extended to include subtotal pancreatectomy.<sup>6</sup> These benefits include decreased LoS, decreased pain medication usage and fewer wound complications.<sup>7</sup> The addition of a spleen-sparing technique also eliminates the theoretical risk for overwhelming post-splenectomy infection and postoperative subphrenic abscess.<sup>8</sup> The safety and potential benefits of this latter approach were evaluated in this study.

Overall, we found that elderly patients tolerated laparoscopic distal pancreatectomy well. The present study group, in which the median age was 81 years (range: 71–92 years) compared favourably with series of younger patients aged 50–59 years in terms of EBL, operative time, LoS, pancreatic leak rates and overall complications (Table 3).

**Table 2** Results comparing age, operating room time, length of stay, estimated blood loss, transfusion and rate of splenic infarction between the splenic vessel preservation (SVP) and splenic vessel division (SVD) groups

Parameter, medians	SVP group (n = 5)	SVD group (n = 4)	P-value
Age	81 years	81 years	0.336
Operating room time	140 min	170 min	0.915
Length of stay	4.3 days	9.3 days	0.053
Estimated blood loss	200 ml	100 ml	0.091
Splenic volume	69.0 cm <sup>3</sup>	59.2 cm <sup>3</sup>	0.201
Blood transfusion	1 unit	0 units	0.429
Splenic infarction, patients, n	0/5	4/4	0.002

The rate of splenic infarction was significantly associated with splenic vessel division; length of stay was longer in the SVD group, but the difference did not reach statistical significance because of the small sample size.

**Table 3** Results of recent large series of laparoscopic distal pancreatectomy with and without splenic preservation compared with results in the current series of elderly patients

Authors/year	n	Age, years, mean	EBL, ml	OR time, min	LoS, days	Pancreatic leak rate, %	Complication rate, %
Taylor <i>et al.</i> 2008 <sup>7</sup> (Brisbane)	46	59.8	139	200	7	15	39
Pierce <i>et al.</i> 2007 <sup>16</sup> (St Louis)	22	56.3	236	244	4.5	27	36.4
Malbrut <i>et al.</i> 2005 <sup>17</sup> (Brussels)	127	52	<sup>b</sup>	190	7	17	31
Fernandez-Cruz <i>et al.</i> 2008 <sup>18</sup> (Barcelona)	52 <sup>a</sup>	57	310	Not listed	7	7.7	25.2
Current study, 2011 (Providence)	10	81	100	180	5	11	50

<sup>a</sup>Series of all spleen-preserving distal pancreatectomies.

<sup>b</sup>Recorded as >300 ml in 29 of 127 patients.

EBL, estimated blood loss; OR, operating room; LoS, length of stay.

The choice of which specific technique of splenic preservation to use appears to be important in these elderly patients. Two spleen-sparing distal pancreatectomy techniques have been described. One technique involves varying amounts of dissection of the splenic vein and splenic artery away from the pancreas and division of the small venous branches to the gland; this is known as splenic vessel preservation (SVP).<sup>9</sup> The other technique, initially described by Warshaw in 1988, involves careful preservation of the short gastric and splenocolic vessels with very distal transection of the splenic artery and vein before distal pancreatectomy.<sup>5</sup> The spleen maintains its blood supply on short gastric flow.<sup>5</sup>

Using the latter technique, symptomatic splenic infarction has been reported to occur in 12–20% of cases, but can usually be managed conservatively.<sup>5,10,11</sup> Additionally, this approach has been associated with shorter hospital LoS, shorter operative time and reduced blood loss compared with SVP.<sup>10,12</sup> Colour-flow Doppler imaging has been used intraoperatively to diagnose splenic infarcts,<sup>11</sup> but no criteria have been described for evaluating the splenic flow pre-resection.

The Warshaw technique is further supported by a series of porto-azygous disruptions for bleeding varices performed in the 1980s.<sup>13</sup> In these patients, the splenic vessels were divided and the authors demonstrated normal splenic arterial blood flow on long-term follow-up, as well as unexpected arterial supply to the spleen from the left gastric artery.<sup>13</sup>

Finally, during pancreas resection for donor transplant, the distal splenic artery and vein are routinely divided with a symptomatic splenic infarction rate of 5–15%.<sup>14</sup> However, the mean donor age reported in one series was  $48.4 \pm 8.7$  years.<sup>15</sup> A study conducted over 30 years at the University of Minnesota into living related-donor pancreas surgeries found only one patient to be aged >65 years (D. E. R. Sutherland, personal correspondence, 6 April 2011).

In the original description of the Warshaw technique, the author recommended against the division of the splenic vessels in the presence of splenomegaly out of concern that the short gastric vessels might not have sufficient calibre to maintain flow to the splenic mass.<sup>5</sup> We share the same concern for elderly patients.

It is our technique to open the gastrocolic omentum and preserve almost all the short gastric vessels with minimal dissection beyond the area where the right and left gastroepiploic arcades meet. Even with these precautions, all four patients in the present study (aged 74, 77, 84 and 92 years) in whom division of the vessels was performed developed significant splenic infarcts, and three required laparoscopic splenectomy for acute infarction with either peritonitis or abscess. No haemodynamic events or differences in terms of risk factors for atherosclerosis that might explain the occurrence of infarcts in this small group were found. However, it is likely that elderly patients do have a higher risk for visceral atherosclerosis, which may compromise collateral splenic perfusion.

It would appear that the short gastric vessels do not supply enough collateral circulation to support the splenic mass in these elderly patients. In addition, the benefits of preserving the spleen in elderly patients may be diminished because these patients have shorter life expectancies and are thus at less risk for developing overwhelming post-splenectomy infection, which occurs at an incidence of only 0.05–2.0% over the lifetime of young splenectomized trauma patients.<sup>11</sup> Although further evaluation is needed, the present authors' current practice is to perform splenectomy in this subgroup if SVP cannot be selected.

## Conclusions

This is the first paper to describe laparoscopic spleen-preserving distal pancreatectomy in elderly patients. This technique appears to be safe in these patients, in whom overall morbidity and mortality rates compare well with those in younger patients. However, preservation of the spleen using SVD may result in unacceptably high rates of splenic infarction. Variables such as atherosclerosis and other unidentified factors, which may contribute to infarction in elderly patients, remain to be elucidated. As we continue to gain experience with this procedure in this patient subgroup, our institutional practice is to perform splenectomy in elderly patients in whom splenic vessel sacrifice is required during distal pancreatectomy.

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## Conflicts of interest

None declared.

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